XXIV. *Experiments and observations on the Newry pitch-stone, and its products, and on the formation of pumice. By the Right Honourable* GEORGE KNOX, *F. R. S.*

Read May 9, 1822.

THE locality of this mineral, and the singularity of its external characters, having excited my curiosity, I took advantage of the facilities furnished by the liberality of the Royal Society of Dublin, of which I have the honour of being one of the Vice Presidents, to make the subjoined analysis in their laboratory.

Doctor FITTON, in an excellent paper inserted in the first volume of the Transactions of the Geological Society, has given a minute description of the site and external characters of the Newry pitch-stone. I shall transcribe it, previous to laying before the Royal Society my own observations. I do so with more satisfaction, as we in general agree; in fact, scarcely two specimens are exactly the same, although contiguous to each other in the vein; some being compact, some thin slaty, some olive, and some leek-green; some so disintegrated, particularly when exposed to the air, as to be friable between the fingers, while others retain their gloss, consistency, and colour, with much tenacity, although they all fall at length into rhomboidal fragments. I may add also, that while some are quite porphyritic, others have but a few specks of felspar on their surface.

However, Dr. FITTON seems to have overlooked two very striking characters of it, which engaged my particular attention, and gave birth to those conjectures, which principally induced me to undertake the analysis by which they have been verified. I mean the *smell*, and strong oily taste.

"This substance (Dr. FITTON observes), is found in a "vein traversing granite, in the vicinity of Newry, in the "County Down. Its colour is intermediate between moun- "tain and leek-green. It is massive. Fracture small, and "not very perfect conchoidal.

"Internal lustre, resino-vitreous, and shining. It exhibits "lamellar distinct concretions; the plates are from one- "fourth to one-tenth of an inch in thickness, and are further "divisible into pieces of the rhomboidal form of various "angles. The surface of the concretions is smooth and "strongly glistening. Slightly translucent on the edges. It "scratches window glass, but is easily scratched by quartz. "Easily broken. Specific gravity 2,29. Before the blow- "pipe, without addition, it yields a greyish-white frothy "enamel. It is in some places porphyritic, containing im- "bedded minute crystals of felspar and of quartz.

"A letter from a very intelligent observer, who has ex- "amined this substance in its native place, states the follow- "ing particulars respecting its position:

"The vein is first observable in the Townland of Newry, "at the bottom of a bank of granite, about half a mile from "the northern end of the town, on the right of the road lead- "ing to Downpatrick. It crosses the road, and runs due "westward, ending on the side of the great road from Newry

" to Belfast. Its length, so far as hitherto observed, is half " a mile.

" The rock, which is covered with mould to the depth of a " foot, consists of a grey granite. The vein is about two feet " and a half, or two and a quarter in width; at the places " of contact, both the granite and pitch-stone are disinte- " grated, the latter being almost as soft as clay, but becoming " gradually harder as it approaches the center of the vein. " The structure of the vein is foliated, the folia being per- " pendicular to the horizon, and also to the walls; and, be- " sides these, there are seams, that run longitudinally, parallel " to the horizon, and nearly perpendicular to the folia.

" Although this substance presents some peculiarity, in " being divisible into rhomboidal fragments, it approaches in " this respect to the *pitch-stone* of Arran, (in lamellar concre- " tions) which holds as it were a middle place between it, and " that possessing the more usual characters.

" Mr. JAMESON has described a vein of pitch-stone " running " in granite" observed by himself in Arran;* and he states " that lamellar distinct concretions have been hitherto ob- " served in the pitch-stone of that island only."†

To the geological account of this mineral, above given, I have only to add, that the granite which it traverses is rather of a soft kind, containing much felspar, and disposed to be converted, by decomposition, into lithomarge; and that a vein of basalt nearly parallel to it, at the distance of about an hundred yards, passes through the same rock of granite. This basalt very readily disintegrates by exposure to air and moisture; and it contains spheroidal concentric balls of basalt of

* Min. of Scottish Isles, 4to. vol. I. p. 81. † JAMESON's Mineralogy, vol. I. p. 261.

a loose contexture; and likewise a considerable quantity of compact stilbite, approaching to fibrous, and of a schistose structure.

I obtained specimens of the pitch-stone of various kinds, compact, thin slaty, and disintegrated; and one of the thin slaty was of a different colour from the rest, darker, more porphyritic, and of a more shining lustre.

The external characters of all agreed in the following particulars.

Specific gravity 2,31. Fracture, small conchoidal; fragments indeterminately angular, rather sharp edged and rhomboidal.—Surface, smooth and glistening.—Feel, unctuous.—Lustre, resinous.—Hardness, semi-hard, the sharp edges scratching glass.—Streak and powder whitish grey, passing into greenish grey.—Smell, *oily*.—Before the blow-pipe, fuses without addition into a pale leek-green glass. Colour of the most porphyritic specimen, perfect leek-green; of the rest, olive-green, passing into oil-green.

Although the peculiar character of this variety of pitch-stone is its smell, yet, I believe, it differs from all others, including those from Arran, in the *degree* in which it is disposed to divide into thin laminæ; its proneness to disintegrate, and the regularity of its rhomboidal fragments. So much is it inclined to disintegrate, that a piece, nearly compact, after lying for some days on the table of a warm laboratory, fell into large rhomboidal fragments.

It will appear, I think, that these qualities proceed from the same cause.

A piece of the compact specimen was exposed for half an hour to a red heat in an open crucible. It lost 7,75 per cent.

of its weight. The colour changed to a pitch brown. It retained its lustre. It opened, in the manner of cannel coal, into thin slaty fragments, but without actually falling in pieces, and the interstices acquired a more greasy lustre, and smoother appearance, than the rest of the stone.

The circumstances above detailed, namely, the *oily smell*, the disintegration, and the effect of ignition, excited a suspicion that the mineral contained some inflammable substance.

One hundred grains of the compact, in fine powder, were exposed to a white heat in a platina crucible, and were converted into a glass of a very pale leek-green colour, and lost ten per cent.

Two hundred and twenty grains of the same, coarsely powdered, were put into a small coated (common bottle glass) retort, to the mouth of which a phial, previously weighed, was luted with white lute, and exposed for half an hour to a red heat. A colourless liquor came over, which had a slightly bituminous smell. The receiver had gained 16 grains, being 7,2727 per cent.

The retort breaking, I was not able to ascertain the loss of weight of its charge.

The stone finely powdered, and projected on melted nitre, scintillated a little.

I now proceeded to my analysis, in the usual way, following the method of KLAPROTH, in his analysis of the pitch-stone from Meissen; my view having been, at first, rather to ascertain ingredients, than proportions.

It may be as well to mention, in this place, the result of KLAPROTH's analysis. It was

Silex	73
Alumina	14,50
Lime	1,00
Oxide of iron	1,00
Oxide of manganese	0,10
Soda	1,75
Water	8,50
	99,85

He obtained his silex by exposing 100 grains of the pulverised stone, along with 200 grains of caustic soda, to a strong red heat, for half an hour, in a silver crucible; when cool, softening with water, dissolving in muriatic acid, evaporating nearly to dryness, diffusing in water, and filtering.

The alumina was obtained by boiling the muriated solution, thus freed from silex, with excess of caustic soda. The alumina was held in solution while the lime and iron were thrown down. The alkali was then neutralised, and the earth precipitated by carbonate of soda. The precipitated lime and iron, first dissolved in muriatic acid, and then combined with sulphuric acid, gave sulphate of lime, which was collected and washed with weak spirits of wine, and the pure lime was estimated as in the proportion of one to three in the sulphate.

The iron was precipitated by carbonate of ammonia. Some flocks, which appeared in the remaining fluid after it had been evaporated to dryness and re-dissolved, were *presumed* to be manganese, and *estimated* at one-tenth of a grain.

I proceeded in the same manner but obtained no manga-

nese; and in the liquor from which the sulphate of lime was extracted, there was no sulphate of magnesia.

The alumina boiled in sulphuric acid and mixed with sulphate of potash was converted into alum, leaving nothing in solution.

The first thing which caught my attention in the course of this process, was the appearance of a black insoluble matter in the muriatic solution from which the silica had been separated. As it evaporated with considerable rapidity, in consequence of the great heat of the sand bath, a rim was left from time to time on the surface of the pan of dry salt, which, from being orange, became white, and shortly after a black powder used to separate from it, fall to the bottom of the pan, and remain undissolved.

This I at first suspected to be oxide of manganese; but having collected it, I found that it was insoluble in acids, and that it burned away at a red heat.

I then conceived that some carbon had accidentally got into the liquor; but as the same phenomena recurred with every experiment, and I repeated my analysis many times, I became convinced that it belonged to the stone. Other circumstances, however, put it out of doubt.

To obtain the alkalies, if any existed in the stone, I pursued each of the methods usually recommended; that invented by ROSE, and practised by KLAPROTH; that of Sir HUMPHRY DAVY; the new process by CERUSE; and the action of acids on the stone; by the last of which I finally abided.

KLAPROTH mixed 100 grains of the pulverised stone with 300 of nitrate of barytes, ignited them in a porcelain crucible, and neutralised the mass with muriatic acid, which he

expelled again with sulphuric acid. The inspissated mass he washed with hot water, filtered, and saturated the filtered liquor with excess of ammonia. The residuum being separated by the filter, the remaining fluid was evaporated to dryness; the sulphate of ammonia having been driven off at a moderate heat, sulphate of soda was left behind. This being dissolved, was decomposed by acetate of barytes, and filtered; the filtered solution evaporated to dryness, and the dry salt exposed to a red heat in a platina crucible. The saline residue was then re-dissolved and evaporated to dryness. It was carbonate of soda.

I have detailed this well known process, chiefly to remark an occurrence in one part of it, which continued to confirm me in the opinion that the stone contained an inflammable substance.

When I was expelling the sulphate of ammonia, I was struck by the melted mass in the crucible, which had before been white, suddenly becoming black, and, as the sulphate of ammonia flew off, gathering into a black powder. This powder being insoluble in water, was easily collected; and, like that which I had got before from the acid solution, resisted the acid, and was volatilised by a red heat.

The alkali which I obtained was soda. By converting it into nitrate, sulphate, and muriate, and observing the crystallization of each, and by testing it with muriate of platina, I ascertained that it contained no potash. It had none of the characters of lithia, neither the crystals of the muriate nor of the nitrate were deliquescent, nor did they tinge the flame when burned with alcohol. When a small portion of the stone, enveloped in soda and placed on platina leaf, was treated by

the blow-pipe, it left no black mark on the metal: it contained therefore no lithia.

I proceed now to my final analysis, premising that, although the last, I think it may be pretty well relied upon. I had made a separate one for each ingredient, giving my whole attention to that which I had selected, without embarrassing myself much with the others.

In this final analysis I adopted a different process, considering it more convenient. My compact pitch-stone being exhausted, I was obliged to resort to the next most compact, and which I call the *slaty compact.*

One hundred grains, mixed with 200 of caustic soda in a silver crucible, were exposed to a red heat. When cool, the contents of the crucible were softened with water and dissolved in muriatic acid. A jelly was formed, by evaporating the solution slowly on a sand bath. When nearly dry, it was diffused in water and filtered. The silica caught on the filter, and exposed to a red heat, weighed 70,8 grains. (*a*)

The filtered liquor *(a)* was evaporated to dryness, and the mass re-dissolved; there remained a powder, which dried at a red heat, weighed 0,75, and was silica. *(b)*

The liquor *(b)* from which the 0,75 of silica had been separated, was precipitated by ammonia and filtered; alumina and iron remained on the filter; the lime went through in solution *(c)*.

The iron and alumina were washed completely off the filter into a silver evaporating dish before they were dry, by projecting against it water, impelled by the breath through a dropping glass; a mode of removing substances from filters always effectual, and far preferable to drying and collecting

the dry powders from the paper. It was suggested by Mr WHARMLEY, Chemical Assistant in the Laboratory of the Royal Society of Dublin.

The alumina and iron thus collected, were boiled in caustic potash until a separation had taken place, the iron remaining as a powder at the bottom of the silver pan, and the alumina being held in solution by the alkali *(d)*.

The iron separated by the filter in the manner above mentioned, was dried and weighed. It weighed 5,25 grains. It was then dissolved in muriatic acid, with which it effervesced, and therefore had been carbonated. A powder remained behind weighing 0,3 grain, which was silica. The iron was then precipitated by caustic potash, filtered, and again evaporated to dryness; it weighed 3,4 grains, which gives of protoxide of iron 3,036 grains.

The solution *(c)* evaporated to dryness and re-dissolved, left a residuum which weighed one grain, and which being insoluble in boiling sulphuric acid, and being perfectly white and gritty, I concluded to be silica. It was then precipitated by carbonate of soda, filtered, washed and dried; the precipitate, which was carbonate of lime, weighed 2 grains. Now, 2 grains of carbonate of lime may be estimated at 1,12 of lime.

The alkaline solution *(d)* was precipitated while hot by muriate of ammonia, filtered, washed, and ignited in a platina crucible; it weighed 11,50 grains.

Extraction of the alkali by acid.

Nitric acid.

100 grains of the pulverised stone were boiled with dilute

nitric acid. When dry, the soluble part was taken up by water and replaced by fresh acid. This process was repeated until the acid seemed to have no farther effect. The aqueous solutions were then thrown together and evaporated to dryness. Alcohol removed the nitrate of lime; and the iron being peroxidated by the nitric acid, nothing remained when the mass was re-dissolved in water but nitrate of soda, which crystallized in cubes, and had every other property of nitre. This being evaporated again to dryness, and weighed, was found to be 7,75 grains of nitrate of soda, which gives 2,857 for soda. I consider this to be the real proportion of the alkali. It differs but little from the following result by

Muriatic acid.

100 grains were treated in the same way with muriatic acid, the iron being peroxidised when the aqueous solution was evaporated to dryness. The chloride of sodium weighed 5 grains. Now, 5 grains of chloride of sodium make of dry soda, or oxide of sodium, 1,98198, being in the proportion 55,5 to 22; but 1,98198 of dry soda produce 2,87044 of hydrate of soda, the state in which it is probable the alkali exists in the stone.

In the process with the muriatic acid two new and decisive phenomena presented themselves.

When evaporating off the excess of muriatic acid from the solution in a platina crucible with a silver cover, I observed the inside of the cover, which I had laid lightly on and removed from time to time, to be coated with a yellow substance, which had a bituminous smell. I placed the cover with the

top down on a chafing dish of charcoal, and in a few minutes the whole was volatilised, and the silver became bright.

On evaporating the alcohol, in order to ascertain how much lime the acid had taken up, I observed a dark oily substance collecting as the alcohol diminished, and which, when the solution was nearly dry, was collected, and weighed 3,70 grains. It had an empyreumatic smell, was insoluble in ether, but dissolved in spirits of turpentine, and inflamed with difficulty with a thick smoke and pungent odour. Naptha dissolved it only in part, and changed the colour to grass-green. It seemed to retain some muriatic acid, and gave indications of containing some iron; it was therefore impure bitumen.

All these circumstances combined to urge me to obtain the bituminous matter of the stone, if possible, in a state of purity, and to ascertain the quantity which existed in it.

I therefore engaged in the following experiments:

I procured an iron retort about 6 inches long and half an inch in diameter, one end of which was screwed to a bent gun-barrel, and the other, or bottom, closed by an iron screw. This apparatus was perfectly well made, and air tight.

Experiment 1.

Into the retort I put 480 grains, in coarse powder, of the dark leek-green thin slaty Newry pitch-stone, as, from its appearance, I judged that that variety contained the greatest proportion of bitumen.

The retort was then enclosed in a long earthen crucible, the interstices being filled up with glass-house sand, and placed in a powerful side furnace. To the end of the gun-

barrel was affixed, and luted with white lute, a glass tube, with a hollow ball near its junction with the mouth of the retort, for receiving liquids, and fitted at the other to a mercurial trough, in order to collect the gases that might come over.*

A considerable quantity of gas came over, in addition to the air of the vessel, and when the retort had acquired a red heat, a liquor distilled which was evidently water.

When the heat was urged farther, another liquor made its appearance. It was slightly coloured and ran down, in oily streaks, into the receiver, where it floated on the water.

When the distillation had ceased the apparatus was removed, all access of air excluded from the receiver, and the gases examined.

They consisted of carbonic acid, which was removed by lime water and caustic potash; of hydrogen, which was judged of by its inflammation; and of carburetted hydrogen, which was tested by adding to a portion of the gas, deprived of carbonic acid, some oxygen gas and exploding by electricity. Carbonic acid was thereby generated, as was proved by its rendering lime water turbid.

The receiver, which had been previously weighed, was now examined. It had gained 7,81 grains per cent.

The oily fluid had the smell of tobacco, exactly that of a tobacco-pipe long in use, and it burned with a similar flame to naptha: while burning it had the same smell as petroleum, which I had collected myself at the Pays de la Poix, near Clermont, in Auvergne. The water was neither acid nor alkaline.

* When I ceased to look for gas, I discontinued the luting.

The experiment was repeated, but without an attempt to catch the gases; and the moment the smell came over the receiver was changed, by which means nearly the whole was obtained, independent of what it suffered from decomposition, and weighed about 2,5 grains per cent.

Experiment 2.

Finding that the iron decomposed the water, and thereby in part the bitumen also, I gave up that apparatus, and had a very strong glass retort, such as is used in the manufacture of common wine bottles, made of a similar shape, and coated, to which a receiver of the same form as those described was luted as before.

I may mention here a very curious appearance of the mass which remained in the iron retort. It was of course of a cylindrical shape; its colour was pale ash-grey; it was porous, semivitrified, and slightly cohering; resembling coarse pumice, and floated on water. But the circumstance to which I now allude is that it separated, when broken, into thin regular tables, precisely in the manner of madreporites, so that it might be considered as schistose pumice.

In this experiment, I gave to 480 grains of the coarsely powdered leek-green variety, a dull red heat for half an hour, in order to expel the water, as I had found that, with that degree of heat, the bitumen was not removed from the stone. I then charged it into the glass retort, inserted in a crucible as before, and gave it a white heat. No gas was generated, nor expelled, and the liquor in the receiver was pure bitumen. It weighed 2,83 grains per cent. and was of a wine-yellow colour, and the smell the same as the last. The neck of the

retort being thinner than the rest had fused, but fortunately not until the whole of the bitumen had come over. The residuum was again a pumice, exactly the same as in the experiments with the iron retort.

Experiment 3.

Slaty compact pitch-stone.

A green glass retort was again charged with the pitch-stone which I had been analysing, namely, the slaty compact; but the neck of the retort, being thinner than the body, fused. On examining the mass within the retort, a light-coloured pumice was found at the bottom, and a dark one at the top.

Experiment 4.

100 grains of the slaty compact pitch-stone which I had been analysing, lost by ignition 8,0 per cent.: when fused it lost 0,5 more, and formed a light ash-grey glass.

Experiment 5.

480 grains of the same were distilled after the water was expelled by ignition, and therefore the danger of decomposition removed, in an iron retort. Bitumen came over, and the process appearing to be completed the receiver was removed, after which some more bitumen dropped from the retort. The bitumen in the receiver smelt more of naptha than the former products, but that which dropped had the same smell of tobacco. What was condensed in the receiver was very volatile, being driven from one end of the phial to the other, namely, by the heat of the hand. The contents of the retort were a light pumice, as before.

Experiment 6.

400 grains of disintegrated Newry pitch-stone which had lost 7,25 per cent. by a red heat, were distilled as usual; 0,1 came over of bitumen, which had the smell and volatility of naptha.

Experiment 7.

100 grains in mass of Meissen *pitch-stone* (the same as that which had been analysed by KLAPROTH, and for which I was indebted to my friend Sir CHARLES GIESECKE, Professor of Mineralogy to the Royal Society of Dublin) were ignited in a platina crucible. The colour changed from oil-green to greenish white passing into greyish green; it opened in the same manner as the compact Newry pitch-stone, showing a tendency to slate, the fissures being parallel; fragments indeterminately angular and rhomboidal, and the lustre altered from resinous to waxy. It was afterwards fused into a white enamel and lost 8 per cent. As KLAPROTH had lost 8,50 by simple ignition, I concluded, erroneously, that it contained no bitumen.

Experiment 8.

400 grains of pitch-stone from Meissen were distilled as usual after ignition: a small quantity of bitumen came over which had the smell of naptha, and was more volatile than any of the former products. The contents of the retort were fused into a greyish white enamel.

Experiment 9.

Having ignited 400 grains of Meissen pitch-stone, and afterwards distilled them in the usual manner, the receiver having

been previously very accurately weighed, 0,5 grain of bitumen were obtained, equally as volatile as that procured in the last experiment. The retort not having received so strong a heat as in the former experiments, only a slightly cohering perfectly white powder remained.

Experiment 10.

On Arran pitch-stone.

I fused 100 grains of pitch-stone from the Island of Arran, in a platina crucible at a white heat; it formed an ash-coloured glass, and lost 5 per cent.

400 grains of the same stone were charged into a green glass retort, as in experiment No. 2. Water came over, and when the heat was increased, was followed by an oily substance; but at the same moment the neck of the retort fused, as in experiment 3, and the distillation ceased. The receiver had acquired an additional weight of 16 grains, that is 4 per cent. It had the smell of the bitumen from the Newry pitch-stone, but faint, and the quantity was too small to be separated. On examining the fused retort, it appeared that, for the distance of an inch from the bottom, the colour of the stone had become, as in former experiments, of an ash-grey, and still resembling pumice, but that the upper part was brown, as in experiment 3; so that it seemed as if the bitumen had risen from the more strongly heated part of the retort, and having been stopped in its progress by the fusing of the neck, had given to the upper part of the mass the same brown colour which I had observed when the whole stone had been originally ignited in an open crucible, as mentioned in the beginning of this paper.

100 grains of the brown part of the residuum of this pitch-stone were then fused, as before, in a platina crucible, into a light-grey glass; it lost one per cent.; thus making up the 5 per cent. which had been the loss from the original fusion.

Experiment 11.

400 grains of Arran pitch-stone lost by ignition 4,5 per cent.; and when distilled in the usual manner in an iron retort, one grain was collected in the receiver, possessing a very peculiar smell. The contents of the retort were a perfect enamel. The receiver was washed with sulphuric ether, which was suffered to evaporate, and a substance remained on the glass pan, but too small in quantity to enable me to examine it.

Experiment 12.

Artificial pumice.

100 grains of artificial pumice, which had been the result of my first and second experiment, were fused in a platina crucible into a greyish-white glass. It lost nothing.

OBSERVATIONS.

I shall, for the sake of distinctness, divide my remarks under heads, beginning with the analysis.

Analysis.

Having mistaken the bitumen which appeared so frequently in the course of all my analyses of the stone, for manganese, and having found, I think, that inflammable substance* in the

* Vide Experiment.

Meissen pitch-stone, will it be presumption to suspect that KLAPROTH made a similar mistake; and that the substance, which he does not appear to have examined, and which he acknowledges he did not weigh, was, in reality, bitumen? This cannot affect the character of this admirable analyst, since there was nothing in the appearance or external characters of the Saxon mineral which could awaken a doubt on that subject; whereas, the peculiar properties of the Newry pitch-stone, naturally, and early, arrested my attention, and would equally have engaged his, had it been submitted to him.

KLAPROTH's assertion, however, that his pitch-stone contained manganese, induced me to institute many experiments to obtain the same substance from mine, and in the course of them I had occasion to try the different methods of separating manganese from iron, recommended by HATCHETT and HERSCHEL.

I mixed perfectly pure oxides of each metal in ascertained proportions, and dissolved them together in muriatic acid, and I found they could be perfectly separated by both methods. I had, at first, some doubts as to HERSCHEL's, but found that my failure had arisen from neglecting to stir the liquor during the precipitation of the iron. In general, I think, the separation is more easy by HATCHETT's mode, but, under some circumstances, HERSCHEL's will be found preferable.

There is one method of obtaining, in an analysis of a stone, the iron combined with the silica alone, and as muriatic acid easily separates them, it may sometimes be found useful. The heat which decomposes muriate of iron leaving an insoluble oxide, does not decompose the earthy muriates; therefore,

if the mass be dried on the sand bath at a heat below redness, when it is afterwards diffused in water, the salts will be dissolved, and the iron and silica will be obtained on the *filter.*

With respect to the alkalies, the fusion with nitrate of barytes is a tedious process, and liable to loss from the frequent filtrations, and also from the necessity of evaporating off the sulphate of ammonia.

That of Sir HUMPHRY DAVY, by boracic acid, is much neater; but, probably from want of analytical skill, I found it so difficult to get rid of the boracic acid, that I was not able to rely upon my result.

The new method, by lead, has its embarrassments also, particularly from the fusibility of the glass which acts upon platina, and penetrates clay crucibles. There is also a good deal of difficulty in getting entirely rid of the lead.

The process by acids, where the nature of the stone will admit of it, is obviously the best; and I found that the nitric acid was to be preferred, as, by its peroxidizing the iron, and destroying the bitumen, those two troublesome substances were disposed of.

Bitumen.

It has appeared, from the foregoing analysis, that this substance may be obtained both in the usual mode of analysing, and by distillation of the stone, but quite pure only in the latter mode. It seems to consist of two inflammable substances, the one much more volatile than the other, but both inseparable from the stone, except at a heat approaching, if not entirely amounting to, whiteness. I imagine that it is in combination with the iron, as it seemed in general to accom-

pany the solutions of that substance, and to modify the colour and magnetic properties of the metal.

It is necessary to observe that, unless the beak of the retort be kept almost at a red heat, as far as the mouth of the receiver, the whole of the bitumen will not be obtained.

This quality renders it easy, however, to ascertain the proportion in which it exists in the stone; a heat of ignition expelling only the water, and the loss of weight by fusing after ignition, giving pretty exactly the quantity of this curious inflammable matter, which appears to vary considerably in the different specimens from the same vein.

I have not yet been able to examine it with sufficient accuracy, partly from want of time, and partly from the difficulty of analysing so small a portion of the substance as I have yet been able to collect. I hope, however, to renew the investigation next winter. If it should be found to be a new substance, I propose to call it *newrine*. I should not be surprised, however, judging from the smell, and its being separable from water by evaporation, if it were found to contain *nicotine* in combination with naptha.

Pumice.

The formation of this substance *artificially*, is rather an interesting circumstance, if it be new; and may throw some light upon its natural formation.

That it is a perfect pumice, in appearance and qualities, what I have already mentioned puts almost out of doubt. It has the colour, levity, and magnetic properties of the real pumice, and deceived artists to whom I presented it as such. An eminent paper stainer, who is in the constant use of that

article, and to whom I sent two pieces, desiring to know, from him, which of the two specimens was the best; answered, that both were excellent, but that the lighter was the best. He had no suspicion that they were an artificial product. If the analysis of pitch-stone and pumice be considered together, it will be found that the water, bitumen, and lime, in the former, are the substances which alter the per centage.

How the lime was got rid of by the volcanic heat is not easily accounted for; but it is conceivable that it may have been acted on by the muriatic acid fumes, which, we know, accompany volcanic fires. Besides, lime may yet be found in some pumice, and none of that earth in some pitch-stones. As yet, I believe, there have been but two pitch-stones, the Meissen and the Newry, analysed, and the former, only, by a chemist of authority. It must be acknowledged, however, that it is difficult to imagine, on this hypothesis, how the alkali remained un-muriated, while the lime united to the muriatic acid.

It appears to be a condition, in converting a stone into pumice, that it should contain a volatile substance, which can only be removed by the same degree of heat which is at the same time necessary for producing that sort of semi-vitrification in the mass which renders it coherent, hard, and porous. If a stone contains only water, pumice is not formed, because that is driven off by a red heat, which does not act upon the earths of which the stone is composed. Drive off the water at a red heat, and you have a harder but incoherent mass: increase the heat, and you have, as in the case of alumine, a more compact and denser substance, or else, when the ingredients of the stone favour vitrification, a glass.

I have made pumice in an open crucible, and with the unpowdered stone, by watching the degree of heat.

Magnetic properties.

A needle, drawn a little out of the direction of the poles by a piece of iron, was drawn back by all the pitch-stones, and by pumice, natural and artificial.

The pumices, as well the natural as the artificial, and the latter, whether obtained by distillation in glass or iron, were attracted, when in powder, by the magnet; but the magnet did not act on any of the pitch-stones under any circumstances.

RESULT.

If the foregoing analysis is correct, that variety of the Newry pitch-stone which I examined contains in one hundred parts,

Silica	72,800
Alumine . . .	11,500
Lime . . .	1, 12
Protoxide of iron .	3,036
Soda . . .	2,857
Water and bitumen	8,500
	99,813

The *Newry* pitch-stone is a *marked variety* of that substance.

It exists in various forms, and the bitumen in various proportions in the same vein.

It contains, as far as at present appears, a peculiar bitumen.

That bitumen exists in the Newry pitch-stone in a larger proportion than in any substance of that class hitherto examined.

The darker specimens appear to contain most bitumen, nearly 3 per cent.

The bitumen, as well as the soda, can be separated from the stone by the action of nitric and muriatic acid, but the bitumen not in a state of purity.

The bitumen can be obtained pure by distillation from the stone by means of a heat nearly approaching to whiteness.

It can be separated from water by evaporation. The Newry pitch-stone is converted into pumice when properly distilled.

It is magnetic, but not so much so as its pumice.

It is not electric, either by heat or friction, neither is its pumice.

It probably owes its *smell*, *slatiness*, and disposition to *disintegrate*, to the bitumen.

The bitumen probably modifies its *colour* also.

The Newry stone agrees, as to its ingredients, with the Saxon pitch-stone from Meissen; but they differ somewhat in their relative proportions, and particularly in the quantity of bituminous matter.

The Arran pitch-stone seems also to contain bitumen; but on this point I cannot yet form a decided opinion.

I had begun a course of experiments on other substances, namely, green-stone, basalt, obsidian, &c., but I have been obliged to discontinue them for the present. I cannot however abstain from mentioning one experiment which failed, as it was attended by a circumstance which gives it some interest.

I ignited 400 grains of green-stone, which lost 5 grains; and charged it into an iron retort as usual. The receiver increased 0,2 in weight, and there was no smell. On examining the contents of the retort after the distillation, I found that the powdered stone had been converted at the bottom into a vesicular glass, and at the top into a pumice, but that a hole had opened in the upper part of the neck of the retort. It seemed therefore that, in the first place, most of the volatile matter must have escaped, whatever that volatile substance may have been, through the hole, but that the temperature having been lowered in its vicinity by the admission of air, the formation of glass was checked as far as that influence extended, and the result was pumice. Why the glass was vesicular and not compact, I shall leave to conjecture. It is probable that farther experiments may elucidate that point.

NOTE.

To assist in forming a judgment whether manganese really existed or not in the Meissen pitch-stone, to 100 grains of the pulverised stone was added 0,1 of oxide of manganese, and fused. The colour was whitish, as before, but as the great heat necessary to fuse the substance might have discoloured the manganese, the following experiments were made. To 99,9 grains of pure white glass, 0,1 of black oxide of manganese was added. It fused into a violet-coloured glass; but when the heat was increased the colour was removed. To try, therefore, whether a violet glass might be produced from a fusion at a lower temperature of

the Meissen pitch-stone, it was first fused with borax by the blow-pipe: no trace of a violet-colour appeared, but, when afterwards fused by the blow-pipe with 0,1 addition of black oxide of manganese, the colour produced was a violet.